91602
new 82-10

92-02007/

ontario hydro
research division

EXECUTIVE SUMMARY

THE INTERFERENCE POTENTIAL OF SIX DIFFERENT RIGHTS-OF-WAY PLANT COMMUNITIES ON ASH, POPLAR, SPRUCE AND PINE TRANSPLANTS

D. Brown

The recent corporate initiative to reduce the use of herbicides in the rights-of-way vegetation management program has placed increased emphasis on the need to develop a vegetation cover which exerts a form of biological control. Such a control strategy was adopted by Ontario Hydro in the early 1970's, when selective herbicide applications were introduced to stimulate the development of vegetation which controls the growth of tree species. Few studies have been undertaken to investigate the success of this strategy. For its effective application, persistent plant species or communities which are able to interfere with the establishment and growth of incompatible tree species must be identified.

A study was initiated in 1988 to determine if the various plant communities which occur on the rights-of-way differed in their interference potentials. Seedlings of green ash (*Fraxinus pennsylvanica*) were transplanted into each of six different communities. Each treatment (community) quadrat was paired with a control quadrat, which was kept free of competing vegetation by covering the ground with a polyethylene sheet. This non-vegetated control was used to standardize the growth and survival of the trees in the treatment quadrats, thus removing site differences due to edaphic, climatic and disturbance factors. This study was expanded in 1989 by including transplants of Carolina poplar (*Populus x canadensis*), white spruce (*Picea glauca*) and red pine (*Pinus resinosa*).

The results of the survival and growth of transplants were specific for both the tree species and vegetation community. There were 3 significant interactions regarding cumulative tree survival: community 2 inhibited ash; community 3 inhibited spruce; and community 3 stimulated ash. Three interactions were significant for the growth in height of the transplants in 1990: communities 2, 3 and 6 inhibited spruce. The cumulative growth of transplants were affected in 3 instances: spruce growth was inhibited by community 2; poplar growth was inhibited by community 4 and community 6.

job	file	date	report no.
34-552-090	834..1	April 16, 1991	91-80-K

The low survival and loss of some sites have severely compromised the experimental design. There is now insufficient replication in 12 of the 24 community: tree combinations to make realistic comparisons. Thus it is recommended that this study be discontinued.

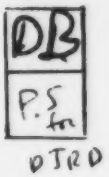

TABLE OF CONTENTS

Section		Page
1	INTRODUCTION	1
2	METHODS	2
3	RESULTS AND DISCUSSION	4
4	CONCLUSIONS	10
ACKNOWLEDGMENTS		10
REFERENCES		11
DISTRIBUTION		last page

TABLES

Table		Page
Table 1	The location and history of the sites used in this study.	3
Table 2	Summary of the number of trees surviving in 1989 and 1990.	6
Table 3	Summary of change in height of the surviving trees in 1990.	7
Table 4	Summary of the cumulative change in height of the surviving trees.	9

FIGURES

Figure		Page
Figure 1	The survival of the trees in the different vegetation communities.	5
Figure 2	The growth of the trees in the different vegetation communities.	8

91601
new 82-10

ontario hydro
research division

To: Dr. D. Mills
Director of Research

THE INTERFERENCE POTENTIAL OF SIX DIFFERENT RIGHTS-OF-WAY PLANT COMMUNITIES ON ASH, POPLAR, SPRUCE AND PINE TRANSPLANTS

1 INTRODUCTION

The development of a right-of-way ground cover which is able to interfere with tree establishment or growth has been a secondary goal of many vegetation control programs. Most utilities attempt to generate this "stable" groundcover through the use of selective application of herbicides (Welch 1991). Egler (1951, 1958) was the first to champion this method. The work of Bramble and Byrnes (1983), Niering and Goodwin (1974), and Pound and Egler (1953) adequately demonstrates that a dense shrub cover may prevent encroachment of trees, while Richards (1973), Horsley (1977a,b) and Sharp *et al.* (1980) argue that some grassland, "old-field" and fern communities will also form persistent, tree-free areas.

In 1989, Ontario Hydro adopted a policy to reduce the use of herbicides by increasing mechanical cutting in the vegetation control program. This change will alter the vegetation composition of the right-of-way (Johnston 1985), with a potential to disrupt many of the stable communities which have developed due to the use of selective foliar herbicides.

A survey of the vegetation on the transmission lines near Essa TS was conducted in 1987 (Brown 1988). This study found 6 distinct plant communities on the rights-of-way. community 1 was dominated by sheep sorrel (*Rumex acetosella*), field horsetail (*Equisetum arvense*), and Canada bluegrass (*Poa compressa*); community 2 by milkweed (*Asclepias syriaca*), strawberry (*Fragaria virginiana*) and sheep sorrel; community 3 by bracken (*Pteridium aquilinum*), strawberry and upright bindweed (*Convolvulus spithamaeus*); community 4 by Canada goldenrod (*Solidago canadensis*), violets (*Viola* spp.) and dandelion (*Taraxacum officinale*); community 5 by strawberry, rough goldenrod (*Solidago rugosa*) and violets; and community 6 by avens (*Geum* sp.), spiny leaved sow thistle (*Sonchus asper*), New England aster (*Aster novae-angliae*) and northern bedstraw (*Galium boreale*).

A study was initiated in 1988 to assess the ability of these communities to interfere with the survival and growth of tree saplings. This report presents the results of this study for the 1990 growing season. The results of the 1988 and 1989 seasons can be found in Brown (1989, 1990).

2 METHODS

The sites selected for this study were those transects identified by the 1987 survey (Brown 1988) to be dominated by one vegetation community. P150 was selected as representative of community 1 vegetation; T634, T738 and T301 were selected for community 2; T369 was selected for community 3; T45, T23 and P123 for community 4; T634, T698 and T255 for community 5 and T834 for community 6 (Table 1). In 1990, 5 quadrats at P150 were destroyed during construction of a new subdivision, while 2 at T45, 1 at T255 and 1 at T634 were damaged by vehicle traffic.

The ability of the 6 communities to interfere with survival and growth of four tree species was estimated using a paired quadrat design. This design was selected to reduce between-site variability in growth due to edaphic and microclimate factors not directly associated with the vegetation by pairing a non-vegetated control quadrat to each replicated treatment (vegetation community) quadrat. The treatment quadrats were spaced 5 m apart in transects perpendicular to the right-of-way. A control quadrat was located 1 m from each treatment quadrat. The vegetation was removed from the controls in May of 1988 and 1989. A double layer of landscaping fabric (a non-woven, spun-bonded black polyethylene sheet (Quest Plastics, Mississauga)) was placed on the bare ground and anchored with nails to restrict the regrowth of vegetation without interfering with water flow into the quadrat. It is assumed that any observed differences in growth between the vegetated and non-vegetated quadrats are due solely to the vegetation cover.

Five 2 year-old green ash (*Fraxinus pennsylvanica)* seedings were transplanted into each 1 x 1 m treatment and control quadrat between May 30 and June 7, 1988. These were thinned to 1 ash per quadrat in 1989. One each of a 5 year-old white spruce *(Picea glanca)*, a 5 year-old red pine *(Pinus resinosa)*, and a 15 cm cutting from the shoot of a 2 year-old Carolina poplar *(Populus x canadensis)* was added to each treatment and control quadrat in the spring of 1989. The height of each tree was measured at the time of planting and in the fall of 1989 and 1990. The annual growth for 1990 was calculated as the mean difference between these heights for the surviving trees in each quadrat.

The data could not be analyzed using the split-plot design, as several of the paired quadrats did not contain any surviving trees. Thus the Students t-test was used to compare growth in the vegetated and non-vegetated quadrats within each community for each tree species. Statistical differences in survival were estimated by using the probabilities for the z statistic in a binomial distribution.

Table 1: The location and history of the sites used in this study.

Tower and Transmission Line	Community Type	Number of Quadrats	Comments
T32 Essa to Alliston	1	12	site removed in 1989
T45 Alliston to Orangeville	4	10	site added in 1989 2 quadrats damaged in 1990
P123 Essa to Stayner	4	10	
P150 Essa to Stayner	1	10	2 quadrats added in 1989 5 quadrats destroyed in 1990
T738 Essa to Waubaushene, west	2	10	site treated with herbicide in 1988
T634 Essa to Waubaushene, west	2	10	site added in 1989 1 quadrat damaged in 1990
T634 Essa to Waubaushene, west	5	10	site added in 1989
T23 Essa to Minesing	4	10	
T698 Essa to Waubaushene, west	5	10	1 quadrat damaged in 1990
T255 Essa to Orillia	5	10	
T301 Essa to Orillia	2	10	
T369 Essa to Orillia	3	20	
T834 Essa to Clairville	6	20	

3 RESULTS AND DISCUSSION

The survival of the trees is summarized in Table 2. Overall mortality was high in poplar and pine in 1990 (66% and 33% of the trees alive in the fall of 1989 respectively). Over all years, communities and treatments, spruce had the highest rate of survival (51%), while poplar had the lowest (18%). A significant effect of the vegetation community on cumulative survival was observed in 3 cases: community 2 inhibited ash survival, and community 3 inhibited spruce survival and stimulated ash survival (Figure 1, Table 2). These results are similar to that observed in 1989, with the exception that community 1 no longer stimulated spruce survival (Brown 1990).

Growth was very poor in 1990 (Table 3). Many of the surviving ash and poplar showed a net decrease in height, indicating death of the terminal shoot and sprouting from the base. This effect was not influenced by the type of vegetation present. Growth of pine was also not affected by the different vegetation communities. Spruce growth was inhibited by the presence of communities 2, 3 and 6.

The cumulative growth for the entire 2 (poplar, pine, spruce) or 3 (ash) years since planting is shown in Figure 2 and Table 4. The ash has yet to recover from the diebacks experienced in 1988 and 1990, thus most of the survivors represent sprouts which have not reached their pre-planting height. The dieback of the poplar in 1990 is not as observable in this figure, as the poplar cuttings planted had an initial height of 0 cm. The different vegetation communities affected cumulative growth in only 3 cases (Table 4): communities 4 and 6 (and possibly community 1, $p = 0.0791$) inhibited poplar, while community 2 inhibited spruce. The significant effect of community 3 (inhibition) and 6 (stimulation) on pine growth observed in 1989 (Brown 1990) was not continued into 1990.

The high mortality and loss of sites have severely compromised the experimental design. There is insufficient replication (< 5 quadrats in both vegetated and non-vegetated treatments) in the ash for communities 1, 2 and 6, communities 1, 2, 3, 5 and 6 in poplar, communities 1 and 6 in pine and communities 1 and 3 in spruce to make realistic comparisons (Table 2). Thus it is recommended that this study be discontinued. The use of transplants to estimate the interference potential of a groundcover is a viable approach, however, more trees need to be planted in each experimental unit to compensate for this high mortality.

There is also considerable year to year variation in the groundcover present on the rights-of-way (Brown 1989, 1990). This may be a response to the year to year variation in climate, or a directional change in the vegetation similar to succession. The change was primarily observed in species with frequencies of less that 75%, but not the dominant 3 to 4 species in each community (Brown 1990). This instability presents two problems. The vegetation at a site may be significantly different at the beginning and end of a study, and the various replicates within a community may not follow the same trajectory with time. These

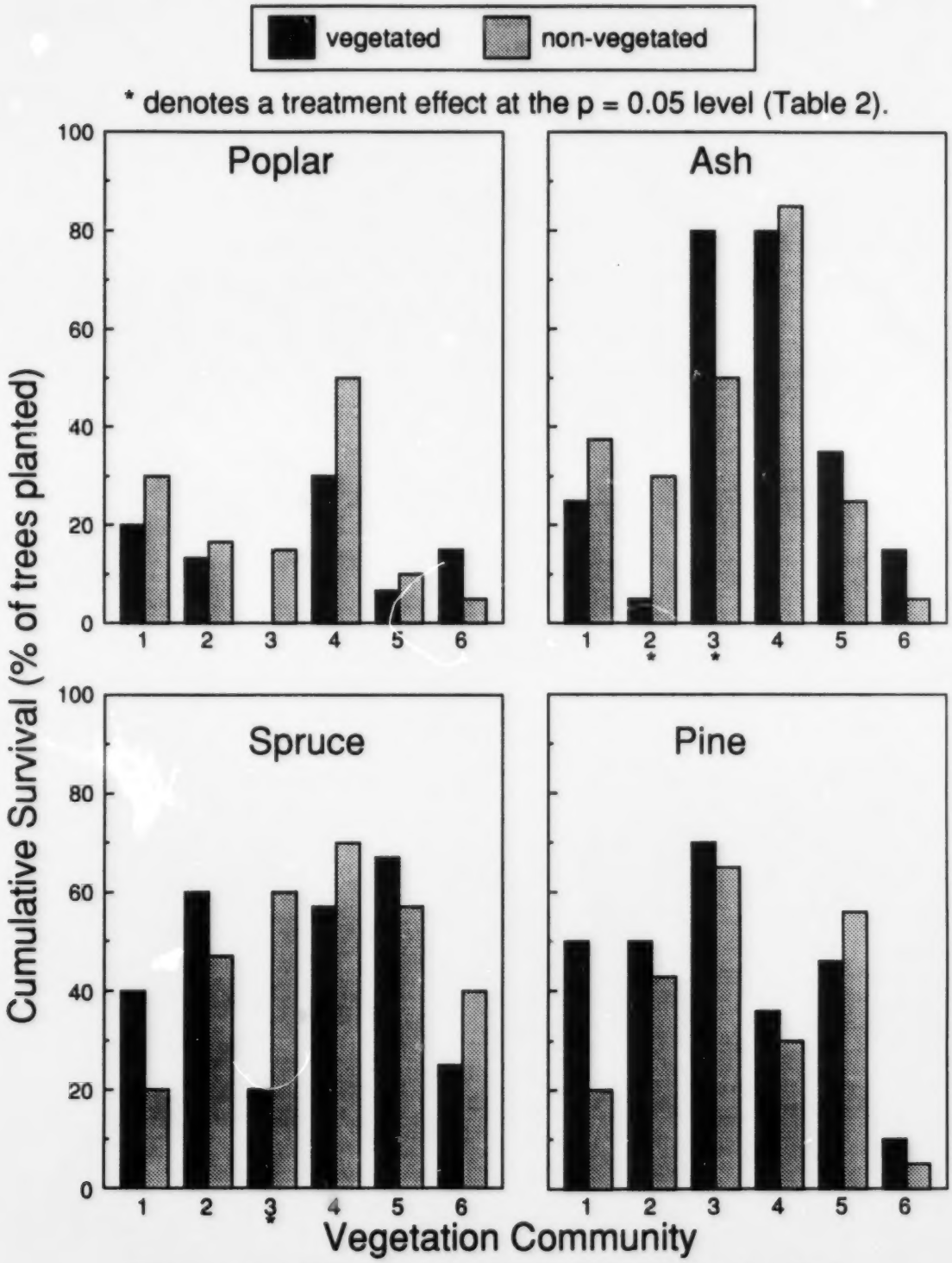

Figure 1: The survival of the trees in the the different vegetation communities.

Table 2: Summary of the number of trees surviving in 1989 and 1990

	Community	Number of Trees Planted	Vegetated Quadrats Number Surviving		Non-vegetated Quadrats Number Surviving		Probabilities for Community effects on Survival[1]
			1989	1990	1989	1990	1989-1990[2]
Ash	1	8	7	2	5	3	0.5892
	2	20	2	1	8	6	**0.0278**
	3	20	15	16	10	10	**0.0271**
	4	20	15	16	15	17	0.7872
	5	20	8	7	5	5	0.4902
	6	20	3	3	0	1	0.2846
Poplar	1	10	10	2	9	3	0.6031
	2	30	12	4	16	5	0.7114
	3	20	3	0	5	3	0.0601
	4	30	24	9	27	15	0.1052
	5	30	14	2	14	3	0.6400
	6	20	9	3	4	1	0.2846
Pine	1	10	10	5	8	2	0.1389
	2	30	18	15	16	13	0.6031
	3	20	19	14	16	13	0.7339
	4	30	20	11	18	9	0.5823
	5	30	19	14	20	17	0.4533
	6	20	4	2	4	1	0.5485
Spruce	1	10	10	4	6	2	0.3173
	2	30	18	18	15	14	0.2983
	3	20	4	4	12	12	**0.0051**
	4	30	23	17	26	21	0.2801
	5	30	21	20	17	17	0.4237
	6	20	8	5	7	8	0.3030

[1] based on *z* statistic (normal approximation to the binomial distribution) calculated as:

$$z = \frac{(a_v - a_{nv})}{\sqrt{\frac{a_v * b_v}{n_v} + \frac{a_{nv} * b_{nv}}{n_{nv}}}}$$

where:
a = probability of survival
b = 1-a
n = number of trees planted
v = vegetated quadrats
vn= non-vegetated quadrats

Significant interactions ($p > 0.05$) are indicated in bold face.

[2] 1988 - 1990 for ash

Table 3: Summary of change in height of the surviving trees in 1990

Community		Vegetated Quadrats change in height (cm) (mean ± SE)		Non-vegetated Quadrats change in height (cm) (mean ± SE)		Probabilities for Community effects on growth in Height[1] 1990
Ash	1	-17.8	0.3	-9.3	9.6	0.6900
	2	-12.0	-	-7.5	3.5	0.2599
	3	-7.5	3.1	-7.6	4.8	0.9891
	4	17.3	5.6	8.4	5.5	0.2736
	5	-4.8	9.6	-8.3	14.3	0.8382
	6	24.0	18.4	118.0	-	-
Poplar	1	-15.4	4.4	-5.6	5.2	0.2821
	2	-15.4	7.3	4.5	7.8	0.1102
	3	-	-	-11.0	5.0	-
	4	0.9	3.3	-1.7	4.7	0.6909
	5	-10.3	9.8	-14.5	1.4	0.6101
	6	19.7	14.8	20.0	-	0.9841
Pine	1	4.3	1.9	2.5	2.5	0.6225
	2	1.5	1.0	1.6	1.7	0.9441
	3	4.7	1.2	4.4	1.4	0.8912
	4	2.5	1.8	-1.5	2.1	0.1605
	5	4.2	1.9	3.4	1.6	0.7534
	6	-5.3	5.8	-3.0	-	0.7625
Spruce	1	6.3	1.2	8.4	2.9	0.4486
	2	1.8	1.5	6.8	1.1	**0.0059**
	3	1.5	2.0	6.1	1.0	**0.0016**
	4	1.4	2.7	3.5	1.3	0.3238
	5	3.7	1.5	7.5	2.1	0.0960
	6	-1.3	4.7	10.6	3.1	**0.0052**

- Value cannot be calculated

[1] Significant interactions ($p > 0.05$) are indicated in bold face type.

[2] Comparison of single point to a sample mean, p determined from the standard normal curve.

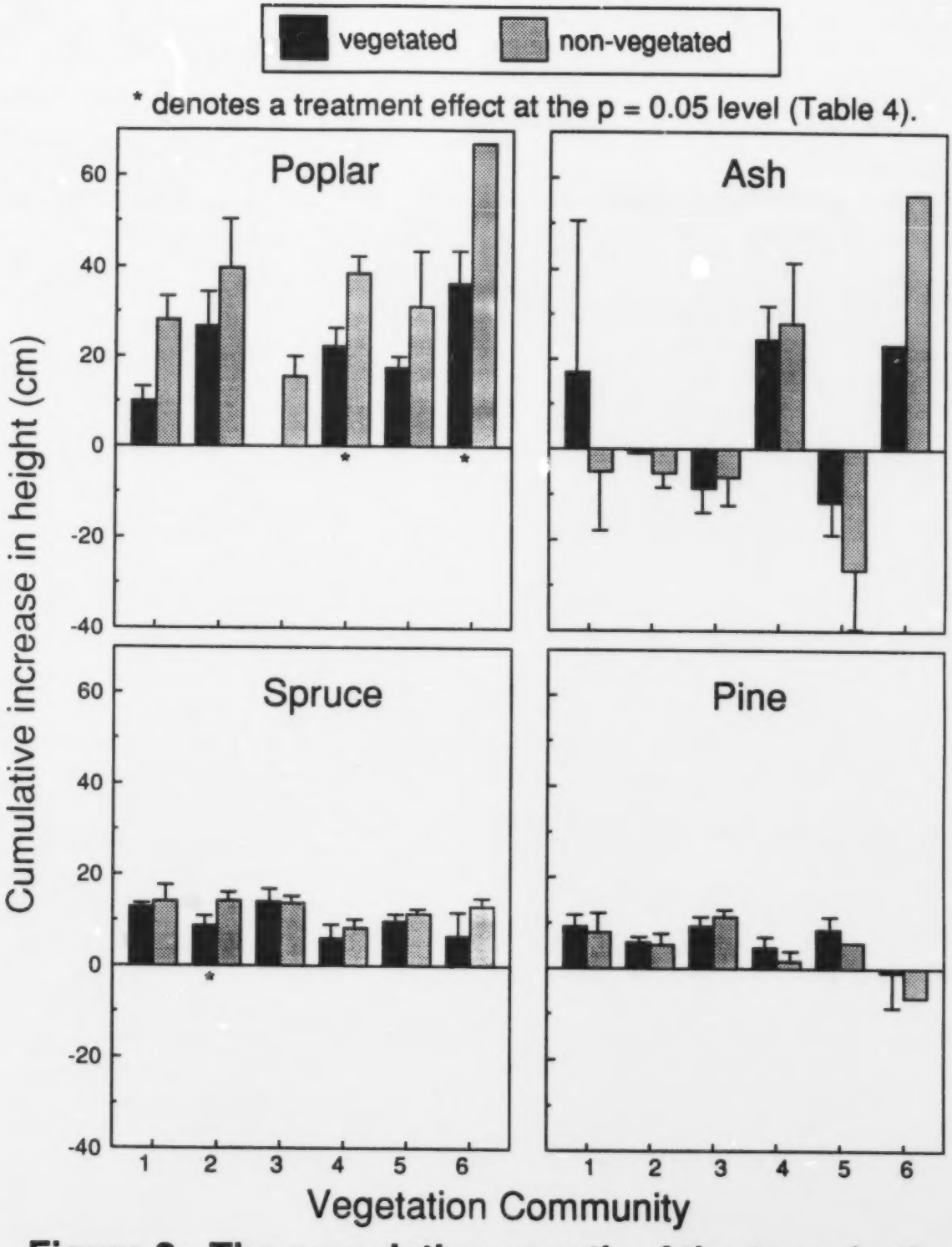

Figure 2: The cumulative growth of the trees in the the different vegetation communities.

Table 4: Summary of cumulative change in height of the surviving trees.

Community		Vegetated Quadrats change in height (cm) (mean ± SE)		Non-vegetated Quadrats change in height (cm) (mean ± SE)		Probabilities for Community effects on growth in Height[1] 1989-1990[2]
Ash	1	17.1	33.5	-5.1	12.7	0.5120
	2	-1.0	-	-5.2	2.9	0.2768[3]
	3	-8.7	4.9	-6.2	6.1	0.7574
	4	24.4	7.6	28.1	13.4	0.8109
	5	-11.7	19.1	-26.6	13.4	0.3069
	6	23.3	-	56.5	-	-
Poplar	1	10.0	3.0	28.0	5.1	0.0791
	2	26.7	7.6	39.6	10.6	0.3806
	3	-	-	15.3	4.4	-
	4	22.3	3.7	38.5	3.9	**0.0115**
	5	17.5	2.5	31.3	12.2	0.4472
	6	36.3	7.1	67.0	-	**0.0061**[3]
Pine	1	9.2	5.7	7.9	6.1	0.8000
	2	5.8	1.2	5.2	2.2	0.8219
	3	9.3	1.7	11.3	1.6	0.3987
	4	4.6	2.4	1.6	1.9	0.3653
	5	8.6	2.5	5.6	1.9	0.3555
	6	-0.8	7.5	-6.4	-	0.2992[3]
Spruce	1	12.9	0.6	14.2	3.5	0.6116
	2	8.8	1.9	14.4	1.8	**0.0492**
	3	14.1	2.7	13.8	1.1	0.9214
	4	6.1	2.8	8.4	2.0	0.4999
	5	9.8	1.6	11.5	1.3	0.4324
	6	6.5	4.9	13.1	1.9	0.1749

- Value cannot be calculated

[1] Significant interactions ($p > 0.05$) are indicated in bold face type.

[2] 1988 - 1990 for ash

[3] Comparison of single point to a sample mean, p determined from the standard normal curve.

problems must be addressed when the study involves natural communities. The inclusion of more sites may provide a way of buffering against these changes.

4 CONCLUSIONS

1. More replication of sites should be included in future studies.

2. Mortality of transplanted trees is high. More trees will need to be planted in each experimental unit to counteract this.

ACKNOWLEDGMENTS

I would like to thank Lori Bremner for her assistance in the field survey, and the staff of the Georgian Bay Region for their willing cooperation in this study.

Approved by:

P. Spehar

for D.J.R. Dodd
Manager
Chemical Research Dept

Prepared by:

Doug Brown

D. Brown
Biologist
Biological Research Section

Reviewed by:

A.M. Sills
Section Head
Biological Research Section

REFERENCES

1. Bramble, W.C. and R.W. Byrnes. 1983. Thirty years of research on development of plant cover on an electric transmission right-of-way. *Journal of Arboriculture* **9**, 67-74.

2. Brown, D. 1988. The relationship between vegetation, soil texture, nutrient status and herbicide treatments on transmission rights-of-way in the vicinity of Essa TS, Georgian Bay Region. *Ontario Hydro Research Division*, Report 88-211-K. Toronto. 35pp.

3. Brown, D. 1989. The stability of six different rights-of-way plant communities in the vicinity of Essa TS and their interference potential on *Fraxinus pennsylvanica* transplants. *Ontario Hydro Research Division*, Report 89-88-K. Toronto. 22pp.

4. Brown, D. 1990. The three year stability of six different rights-of-way plant communities in the vicinity of ESSA TS and their interference potential on ash, poplar, spruce and pine transplants. *Ontario Hydro Research Division*, Report 90-166-K. Toronto. 15pp.

5. Egler, F.E. 1951. The unsuitability of certain grasslands as right-of-way vegetation cover. *Proceedings of the fifth annual meeting of the northeastern weed control conference* pp. 251-254.

6. Egler, F.E. 1958. Science, industry, and the abuse of rights-of-way. *Science* **127**, 573-580.

7. Horsley, S.B. 1977a. Allelopathic inhibition of black cherry by fern, grass, goldenrod, and aster. *Canadian Journal of Forest Research* **7**, 205-216.

8. Horsley, S.B. 1977b. Allelopathic inhibition of black cherry. II. Inhibition by woodland grass, ferns, and club moss. *Canadian Journal of Forest Research* **7**, 515-519.

9. Johnston, P.A. 1985. Long-term right-of-way effectiveness. *Empire State Electrical Energy Research Corporation*, Research Report EP 83-15.

10. Niering, W.A. and R.H. Goodwin. 1974. Creation of relatively stable shrublands with herbicides: arresting "succession" on rights-of-way and pastureland. *Ecology* **55**, 784-795.

11. Pound, C.E. and F.E. Egler. 1953. Brush control in southeastern New York: Fifteen years of stable tree-less communities. *Ecology* **34**, 63-73.

12. Richards, N. A. 1973. Old field vegetation as an inhibitor of tree vegetation. *In: Powerlines and the environment. Edited by* R. Goodland. Cary Arboretum, Millbrook, NY. pp. 78-88.

13. Sharp, W.C., R.S. Ross, M.W. Testerman and R. Williamson. 1980. Ability of crownvetch to suppress woody plant invasion. *Journal of Soil and Water Conservation* May-June 1980, 142-144.

14. Welch, W.E. 1991. Stability of plant communities on transmission line rights-of-way. Draft Report of CEA project 173T576.